Presidential Commission
for the Study of Bioethical Issues

TRANSCRIPT
Speakers' Roundtable

Meeting 1, Session 5
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Amy Gutmann:
I want to thank our panelists. We have had a terrific first day so far of presentations and questions. As someone once said, good questions outrank easy answers. Nobody tried to give us easy answers, and I thought all the questions from commission-members and public were really excellent and will help us a lot.

I have spoken to all our commission members at our break, and they agree that today's presentations, questions, and answers have really helped us. One possible answer to the question of how we're going to process different worldviews--faith-based views, non-faith-based views--is quite … Let me just answer that quite directly from my own perspective: we would be unwise to think we have the answers now before listening to different perspectives and listening to the arguments and reasons that they give.

When it comes to writing our report, we will write what we think is the best advice and recommendations to the President, given what our charge is. And we will do so with all respect to the views we have heard, but not in entire agreement with all the views we have heard. That would be impossible. It may be that we don't entirely agree with any of the views we have heard. But we will do our very best—but we will only be arriving at conclusions after we hear more. And this is the beginning. And, so far, it is an excellent beginning.

That said, I don't want to lose any time. And I'm going to open it up to the …

Oh, there you go.

Microphone technician:
I'm sorry.

Amy Gutmann:
No, you have no apologies. Thank you very much for the heroic effort to get another microphone here….

So, the question I want to lead off with is a very direct question—and I want direct and succinct answers from the presenters—and that is:

If there's one recommendation you could make to us for what we should include in our report, what would it be?

Just one. I know it's hard to pick just one. But it would be helpful for us to know what you think is really important that we address.

Bonnie.

Bonnie Bassler:
I would say you have to be very careful not to restrict the creativity, the ingenuity, and the innovation of scientists going forward in this field.

Amy Gutmann:
Others? Let me just read, if I can, the charge to the commission in the letter that I received--the May 20th letter--because I think it outlines our charge very well. Here we go.

So, it asks us—and when you are asked by the President to do something, it's my philosophy that one does it, especially when it is as reasonable as this is: "In its study, the Commission should consider the potential medical, environmental, security and other benefits of this field of research, as well as any potential health, security or other risks. Further, the Commission should develop recommendations about any actions the Federal government should take to ensure that America reaps the benefits of this developing field of science, while identifying appropriate ethical boundaries and minimizing identified risks."

Now, the one interesting fact about this charge is that it asks us to develop recommendations that ensure that America reaps the benefits of this developing field of science, while identifying ethical boundaries and minimizing risk. And I say that because, Bonnie, your recommendation to us is absolutely consistent with this charge.

Jim, would you like to chime in, in absolute agreement or counter point perhaps?

Jim Thomas:
No, no. I think an appropriate boundary is the laboratory door. And

this technology kept within the laboratory door is an opportunity for the creativity and imagination of scientists to further understand the frontier of knowledge. But that's the boundary that shouldn't be crossed at this time: so, no environmental or commercial release.

Amy Gutmann:
And let me just say that several people mentioned the precautionary principle without defining it. But the definition that I have seen in the literature of the precautionary principle is "don't go ahead until one can prove there are no risks." Is that too strong, Jim?

Jim Thomas:
There are several definitions of the precautionary principle.

Amy Gutmann:
Just so we have…

Jim Thomas:
Where there is evidence of risk of harm, even when that harm isn't yet proven, that should be a basis of not moving ahead.

Amy Gutmann:
Okay.

Jim Thomas:
So it's not as straightforward as "don't do it until you can prove it's safe." You can never prove everything in the world as safe. But where there are concerns, you don't need overwhelming evidence of lack of safety of risk to stop something. You can stop something with just some risk.

Amy Gutmann:
That's good. Because in something that the ETC Group wrote, it was even stronger than that…. I'll take that. I don't want to get side-tracked.

Allen.

Allen Buchanan:
I would emphasize not just benefits to the U.S.A. but to mankind,

to humankind. I don't think this should be a sort of--I know you're not saying it, sort of rah-rah nationalist, "Let's get ahead on synthetic biology for the U.S." I think you need to think about the benefits to human beings and the distribution of the benefits and risks because the people who are benefiting the most may not be the people bearing the greatest risk. So I would take a more cosmopolitan view.

Amy Gutmann:
Two points you made: One is we don't need to stop at the boundaries of this country. But the second point is to think about the distribution of the benefits and the risks and the harm. And that, I think, is something that nobody here has disagreed with. I mean people may have different views of that. But it's very important for us that is part of what we see as the charge of ethics and social responsibility. We're really in the charge. It's interpreted quite broadly. And I think legitimately so. Yes.

Paul Root Wolpe:
There are many different mechanisms you can use to regulate a technology. And I think the commission has to think seriously about which regulatory mechanisms they are going to recommend in so far as they need to recommend a mechanism that is flexible enough to be nimble in a rapidly changing technology that's going to be different five years from now than it is now, so you don't want Draconian or overarching regulations that stifle innovation and yet can also respond to new situations, to limit or stop things that might actually end up being dangerous. You need more of an oversight committee kind of way of thinking about it, though that oversight committee may not be the exact correct mechanism. Then you need a set of laws on the books that right now create boundaries of this technology.

Amy Gutmann:
Yes.

Allison Snow:
Hi. Yes, as I have said before, I don't think there has been enough discussion of specific cases of environmental risk and what they involve in terms of harms. And I feel that it may be time for the National Academy of Sciences to put out a report on, you know, what are the potential harms that we need to be concerned about. And this

could serve a double purpose--I almost said "dual use"--but a double purpose of educating the public and also moving the conversation forward to be away from sound bytes, which I don't like, like "we're going to save the environment and have biofields that are wonderful with no consequences." I feel like a more deep analysis by, for example, a committee at the National Academy of Sciences, an NRC [National Research Council] committee would be a very good outcome.

Amy Gutmann:
Jim. Go ahead.

David Rejeski:
I think looking back at what we did for the past 10 or 15 years on nanotech, I think there are interesting lessons there, though it's not a perfect analogy. But, as Jim said, it rhymes. I think the thing that we didn't do early enough and seriously enough was look at implications research.

There's a tendency to push the gas ahead on the applications and the brake on the implications. Now, there's three things that have to happen, to sort of send the message to the world that you're serious about implications:

The government needs a strategy that goes beyond biosecurity and basically the biosafety issues. You need more agencies involved--E.P.A. [Environmental Protection Agency], OSHA [Occupational Safety and Health Administration], F.D.A. [Food and Drug Administration], the Forest Service--they all have to be in the room;
You got to have some serious money funding research that's going to the right agencies and right research institutions. So we're talking tens of millions. Right now we're nickel and diming the implications research;
And you need periodic review. The National Academy, in the case of nanotech, we use PCAST [President's Council of Advisors on Science and Technology] and we also used the General Accountability Office;
So I think that whole piece is important—being able to say, "We're doing the applications, but we're also very aware of the implications, not just the environmental ones but some of the social ones that Jim was talking about. And we're serious enough to put serious money behind it. We have a strategy. We're making sure that's evaluated on a

regular, periodic basis."

Amy Gutmann:
And this underlines the point that we really take seriously that it's much better to do things proactively.

David Rejeski:
Right.

Amy Gutmann:
And to really assess risks and take the measures that are needed ahead of time, rather than waiting.

David Rejeski:
And I think this is something that the public wants. They expect it. I think the idea of being able to get the research ahead of public concerns is extremely important, even if you don't have the answers, to be able to say there's a serious effort there to get them.

Amy Gutmann:
Yes.

Michael Rodemeyer:
If I can just follow up on that, I think-- and I'm sure David would agree with this--a key element of that is transparency.

In our typical regulatory regime now, risk is generated by private companies that are going to an agency for an approval process. Very little of that information is made publicly available. And one of the great debates on genetically engineered organisms that because of confidentiality and other restrictions, those risk assessment decisions get made essentially behind closed doors so if we can have a publicly funded research effort that looks at risk assessment methodologies, looks at implications research, makes that transparent as good science should be done, I think it will go a long way not obviously only to developing this body of knowledge in parallel with the development of technology and helping to build public confidence that the technology is being discussed in the open, and to build a knowledge base for the regulatory agencies when they need to use it.

Amy Gutmann:
Good. George.

George Church:
I'll try to frame this as the one recommendation, but it's also quite--I'm being quite reactive to what's going on in a positive way, hopefully here. But I would actually and this will sound ironic, I would go further than Jim is going in the sense that I actually think that the drawing the line between commercial and academic is dangerous in the sense that I think the academics are capable of releasing things in the environment much more problematic than what a company would do because of all the extra steps that go into approval and investors and so forth while academic, especially an unrestricted and creative one as Bonnie would have--now, I'm not saying--[AUDIENCE LAUGHTER]--No, as Bonnie would like to have us all be….So I also would like us to be unrestricted and creative. But I think drawing this line with commercial is not….

And so what we need is something--not just one NAS report--but an ongoing report that's going on all the time where we're constantly doing cost-benefit analysis. And I think that is best done in the context of a larger project. And, for example, the Genome Project set aside a considerable fraction of its sums to ethical, legal and social implications. I would add to that policy and economic considerations. That would be my one recommendation.

Amy Gutmann:
Good. And that actually picks up on Nancy's and Allison's continual reassessment and a mechanism in place.

George Church:
But it has to be integrated.

Amy Gutmann:
Right. Other "one" suggestions? Yes.

Drew Endy:
This is the best conversation I have seen on synthetic biology since I have been involved with it. And I think that has to do with the fact that it's coupled to the President, and it is coupled to executive

leadership. And to complement the two remarks around sustaining what leadership can do in this field, you are unlikely, even in the best case scenario, to get everything sorted as the world is today within the deadlines you've got. And it's certainly the case that things will change.

So there can be no question there has to be some sustaining activity. But I think what we're finding here--and I guess it would be my one amendment to sustaining activity--is to enable one to be ethical in this field, one also has to also consider how to enable the field.

And so it's not a typical discussion of bioethics. It's a discussion of how investments and technology development and the science and the law and the ethics all come together. I don't know, I've never seen a sustaining venue that enables all of that to happen. But you've sort of captured it here somehow. Right?

So maybe it's this group of people or the next version of us with a different name. But let me encourage it to not just be a sustaining consideration of benefits, dangers, costs. But how we actually make this all work.

Amy Gutmann:
Well, we have captured it. And there needs to be a "we" going forward that doesn't simply issue a report into a black hole. We need some ongoing--it came up--education and understanding of whatever turns out to be a set of reasonable recommendations for how we can both benefit from and minimize identifiable risks..

Drew Endy:
Let me try and say something more clearly think it's very significant to have executive leadership on this topic. And I think whenever you are trying to do something new, there's skepticism about utility. There's concern about risk. And there's a disbelief. And so I think there are logjams all over the place where people want to be working together on this in different agencies at different levels. But they are not enabled. And there is something very powerful and special and essential about having executive leadership associated with leading.

Amy Gutmann:

Good. We've got it.

Kristala.

Kristala Prather:
One of the things that's come up over the course of today is how exciting this technology is and particularly how it is percolating down to younger and younger people and perhaps in a distributed way to people outside of institutions.

So the one recommendation I would like to see--I don't know the answer to this. I'll say that up-front. But I think there needs to be considerable thought as we go forward thinking about risks and regulations and how all those play and interplay with one another and interact with one another. How do you have that conversation in the context of extra institutional or noninstitutional players or participants? Figuring out a way to be educated about that and to be as constructive as possible to still have the surveillance that George has talked about and the monitoring that others have talked about--but to not automatically think that immediately goes to what our Federally funded researchers at academic universities are doing….

Amy Gutmann:
So this I think raises to the higher level what Drew earlier said about wanting it to do it together rather than do it yourself. That's very good. I'm going to just invite, not only the presenters but anybody in the public and just urge you, anyone who is interested to send us written comments. We, the commission, will read them and I'm urging you to think about the one thing that you want us to address in the report because we'll read whatever you send us, but I'm telling you what would be really helpful, if we just discovered what is truly important to you, rather than a long, long list, which we would also read, but it won't be as helpful as this kind of really focusing on what we need to do to make our recommendations and these deliberations most productive. And with that, I'm going to ask Jim if he wants to ask a question.

Jim Wagner:
Yeah, I'm dying to ask some questions. But I also know--would you mind if we intersperse some of the public questions? I know I saw

some people pop up when you said "those of you with interest…" They almost charged the microphone.

Amy Gutmann:
Why doesn't someone pop up quickly but I want to give commission members time. We will intersperse it. I was going to do it in order.

Jim Wagner:
I feel like I short changed them in the last session. It's guilt.

Amy Gutmann:
We will compensate. I have a lot of Jewish guilt, too.

[AUDIENCE LAUGHTER]

Here we go.

Gerald Epstein:
I'm Gerald Epstein at the American Association for the Advancement of Science. My one recommendation is to be clear about implicit assumptions that you may be building into something you say. The demand of the study is synthetic biology, but lots of the things we talked about pertain to innovation as a whole or biotechnology as a whole or social equity as a whole. To the extent synthetic biology cannot make other problems worse, it's certainly worth bringing these up.

But if the net effect to focus on synthetic biology when your goal is actually much broader than that is to distort the innovation claim or to not solve the bigger problem, that's a concern.

One example might be--pardon me for picking on you, Jim. The criticism about going to a bioeconomy, if you are worried about that and the consequences of going to a bioeconomy, there's four things that are the alternative to that: (1) You love fossil fuels. That's great. (2) There's a new kind of technology that's going to solve the problem outside of our domain and we'll hope that takes care of it. (3) We'll go globally to a lower energy Intensity. Or (4) find some way to get rid of a couple of billion people because the planet can't support all of them. Be clear of the assumptions you're making when you focus on

them.

Amy Gutmann:
We will definitely do that. And we are not going to--I can assure you we're not going to pick on synthetic biology and blame it for all of the world's problems or see it as a cure, or its prohibition as a cure, for all of the world's problems. So that point was not lost on us. I'm glad that you made it, but it's also our charge to look at synthetic biology broadly, not only for what it has done to date but what its implications are moving forward and how it relates to other field, hence the kind …

Jim Wagner:
Connected to that, the question comes on my head, if we can't get this answered, let's give it two minutes to see if it converges. But I do wonder if one of the contributions the committee could make might actually propose a comment just made to be able to give a better definition to what we understand synthetic biology to be. I went back over my notes. I have five definitions we were offered and not necessarily complementary ranging from DNA construction to be the number one technology of the 21st Century, to having it defined as synthetic genomics that must exist in digital code and processed in the genome and activated in a living system, to others saying this is really just an extension of genetic engineering, and, in fact, one person saying there's no clear distinction between synthetic biology and genetic engineering. We had one definition offered saying it was making biology easier to engineer. If all of those are true and you're just asking the commission to kind of sweep them into a whole, we can try to do that. But I hate to have all these scientists leave the room without my having asked: Have I missed the definition for synthetic biology?

Amy Gutmann:
You haven't gotten them all.

[AUDIENCE LAUGHTER]

Jim Wagner:
You're probably right.

Amy Gutmann:
Well, I remember Dr. Prather told us if you had five in the room, we'd get six definitions. So let's see if we can get another one.

Drew Endy:
Well, I refuse.

[AUDIENCE LAUGHTER]

And my counsel to you would be don't stress out about it too much. I have seen, particularly in Europe, meeting after meeting creating meeting after meeting with the primary agenda item being to come to a definition.

Jim Wagner:
Then I suggest we don't discuss it further.

Amy Gutmann:
I can reach a consensus on that one. Let me just say I've got a note here that says next time you invite commentary, you can mention our public email address. So I'm going to invite commentary again in order to mention our public email address. Info@bioethics.gov.

Nita.

Nita Farahany:
This may not be a fruitful question in light of the abandonment of having any definition of synthetic biology. What I'm hoping is for some idea of what the unique risks are that are posed by synthetic biology as opposed to any of the other fields that we have discussed today. And, you know, this may not--this may be difficult to characterize if we don't have a clear sense of what's included and what isn't.

Really, what's different in the risk that this field poses as opposed to previous fields or previous types of biotechnology?

Amy Gutmann:
The answer can be nothing.

Drew Endy:

I can't speak to this comprehensively. But in the Sloan Foundation study done with Dr. Epstein and Garfinkle and Friedman, on synthesis of DNA, we faced the same challenge: What's unique about the tools, process, and science of synthetic biology from the risk perspective?

In that case we were looking at oftentimes security risks.

To give you a specific example, we identified three types of viruses for which direct synthesis from information would be the best available technology for providing access:

Things that weren't available that didn't exist at this time: the 1918 influenza;
Things that are locked up: smallpox, and;
Things for which the reservoir is not clear: ebola.
Beyond that it seemed there wasn't a specific delta-increase in risk due to the tools, bounded within the arbitrary ambiguous definition of the field.

I haven't seen it done beyond security and human pathogens, but I'm sure you could quickly work that up and sketch out how big a puzzle it is.

Amy Gutmann:
The parallel question, by the way, is: what are some of the unique benefits of the field?

Jim.

Jim Thomas:
I just wanted to throw in an example of what I think is a sort of unique thing that comes out of synthetic biology, although it's an extension of an existing problem, it's unique in how it plays out. And that's in the ability to enable digital biopiracy, which hasn't come up yet. Piracy has been declared a bioethical issue.

Until now, ever since the 16th century, if you wanted to take biological materials from communities, say, in the global south, you'd have to go there and take them and physically remove them.

Now, we have an international regime being put in place to try and prevent that movement of the biological materials. Synthetic biology means that in fact you don't have to go there at all. You can download it from the Internet. You can upload it to the Internet and send the information.

So that's a difference in-kind I think is unique.

Amy Gutmann:
Raju.

Raju Kucherlapati:
I was struck by a couple of comments, One made by Allen Buchanan and the one by David [Rejewski] about sort of deja vu from 25 years ago and thinking about, you know, issues dealing with the genetic engineering or dealing with the nanotechnology. So the question that I have is that:

Are there lessons we have learned either from the process or the outcomes of those discussions that would be very helpful for us in thinking about this issue?

Amy Gutmann:
Allen, do you want to take a stab at that? You have been there before. Put your red light on. Counter intuitive, the red light means go.

Allen Buchanan:
You shouldn't assume that the commission report making an impact on bioethics literature is the same as making an impact on public opinion or public knowledge. That's one thing I would say. And the other is I think there's a danger brought up a minute ago of doing a report on synthetic biology without making it clear that it's just part and parcel of much larger issues of scientific innovation. Those are two lessons I think you can learn.

Michael Rodemeyer:
If I could respond to that, too, I think one of the other lessons is that applications matter. The way the particular trajectory of the development of the biotechnology, particularly with respect to genetically

modified crops and food, ended up being an enormously polarizing debate that we still have repercussions from today. You could envision a different rollout of that technology that would have had a very different kind of worldwide greeting, I think. I think the other issue from a regulatory perspective is that I think we certainly have learned--particularly with the regulation of plants--that the goal of having 100% segregation of the genetically engineered plants does not work. It's just not a feasible goal. Now, again, that goes back to the issue of containment and control. You may have a different opportunity here, but that issue has in fact created--while not environmental or health issues--has created some economic challenges for farmers, especially.

Amy Gutmann:
Public questions. You need the microphone. Go ahead.

Gaymon Bennett:
Yes. Gaymon Bennett, the Director of Human Practices at the BIOFAB.

A comment, and then a question.

First, on the question of what I think that this commission should be focused on, we have heard a lot today about biosafety and questions of contamination. And a little bit about biosecurity and the question of malicious action. I think the third agenda that Dr. Endy raised on his slides is the question of preparedness. If something negative happens either unintentionally or intentionally, how are we prepared to respond? I think the question of preparedness is particularly useful for this kind of a commission because it goes to practices, habits, and dispositions which are really at the heart of ethical matters. That was my comment.

The question I would like to pose to Drs. Kaebnick and Buchanan was the question that was actually raised in the morning in both sessions in the morning. And I would like them to answer the question, but in light of comments that Professor King made in the afternoon, the question is: what is distinctive about synthetic biology today relative to other moments in the development of biotechnology and genetic engineering in particular?

And I took that question to mean what's really significant about it today. And this morning when the question was posed, the response turned on what was distinctive about the technology. Professor King invited us, in the afternoon, to think in the way of which context makes something significant and relevant. I'd like to ask Dr. Kaebnick and Dr. Buchanan if they could reflect about what is distinctive about the context within which synthetic biology is emerging that might tell us something about the ethical calculus.

Amy Gutmann:
Greg and Allen. Greg, you want to begin? Allen, you want to begin?

Allen Buchanan:
Well, I think the ethical context is that people are very worried about environmental damage and global warming in particular, so there might be a tendency to have unduly high expectations for synthetic biology doing away with the need for fossil fuels or something. So that could distort the debate. But, otherwise, I can't think of anything that's peculiar about the context that's different from the context in which genetic engineering has been evolving for the last couple of decades.

Amy Gutmann:
Thanks. Greg.

Greg Kaebnick:
I feel like anything I say about this is going to be very speculative and ill-founded. But synthetic biology is sometimes described as the beginning of a new Industrial Revolution. We have had one Industrial Revolution and now that's sort of coming to an end and we have an opportunity, maybe, to get in front of this whole new wave that might, as Jim has pointed out, completely overturn existing modes of production and distribution of a lot of basic goods. And so that strikes me as a salient consideration here.

Amy Gutmann:
Let me just turn the comment about preparedness into a question for any of the presenters because we didn't really address that. We'll take some deep dives later into some of these. But does anybody have some insight on the preparedness issue and how we should approach

it? Yes. Rob.

Rob Carlson:
I have a bunch of stuff in my head that is the result of listening to many provocative comments throughout the day. I'll do my best to stick with that. When the 1918 flu virus was first published and then the virus was re-constructed, there were a number of—let's call them—"vitriolic" public commentaries about how we have given bioterrorists the best weapon they have ever had, forgetting how hard it was to rebuild the virus.

If you talk to people who build viruses for a living, build pathogens particularly for a living, they will tell you that viruses fail most of the time. Whether it's SARS, or the 1918 flu, or what not, the funding, the tens of millions of dollars of funding, that goes into efforts to rebuild pathogens, to figure out how they work, results in success a small fraction of the time.

So I find it unlikely in the near-term that any amateur is going to pull that off successfully.

In the medium-term/long-term, it's going—I don't know—it's going to get easier. I think it was Terrance Humphrey, who was partially responsible for helping reconstruct the 1918 flu, who said, when the virus was published among the public comments was, "Yes, it's true. It's becoming easier to write pathogens from scratch."

But our real problem right now is that nature is the best bioterrorist.

And I would just go back to my comments about SARS this morning. If SARS were to come back today, we would have no better response capability than we did the first time. There's still no human vaccine for it. We would be better at diagnosing it and finding it at the beginning, but it's unclear we would have any better clinical response to it. And I suggest that's probably true for most emerging pathogens. I hope that in fact we get synthetic vaccines in the next year for the flu. That would be fantastic. My suspicion is that issues will arise—as they have for the last five to 10 years—that worries about synthetic vaccines will stand in the way.

Amy Gutmann:
There was a question. Yes. Question.

Unidentified Audience Member:
This is a question to give you some historical perspective that you may not. In view of the fact that most, if not all reports of Presidential Commissions in the last half century have gone to the dead-letter office, and in view of the polarizing issues that you are discussing, you have a difficult task of finding a way to make your act of deliberations consequential.

Amy Gutmann:
We do indeed.

[AUDIENCE LAUGHTER]

Let me point out: that is the challenge of anybody who wants to make anything consequential in government. We are an advisory body. But let me just point out that President Clinton's NBAC [National Bioethics Advisory Commission] was asked shortly after it was formed—like we have been asked by President Obama shortly after we have been formed—in the case of NBAC, it was asked to issue a report on cloning after Dolly was cloned. And shortly after that report was issued, President Clinton actually agreed to some of the major recommendations of the report.

Congress never acted on those recommendations, but several states did. And the report was quite influential. And aside from the fact that, as Drew has pointed out, the President has actually asked for recommendations and been very specific in our not only asking for recommendations, but constituting a commission that includes three members of relevant agencies that might be asked to consider some of these considerations. The value of our report, if we write it clearly, is that it will be—far from going into the dust bin of history—it will actually there for the concerned public to read, as a possible antidote to the immediate sound byte reactions that are almost always more extreme and more simplistic than the educated public and the concerned public, both here and abroad, would like.

So, that is our hope, expectation, and challenge. Thank you very

much for expressing what I'm sure you are not unique in holding.

Brian Wells:
Hello, my name is Brian Wells. I'm the Chief Technology Officer at Penn Medicine.

I have the privilege at Penn of helping the clinicians and researchers in the pursuit of benefits of personalized medicine. Personalized medicine is the treatment of disease in an individualized patient based on genotype and not phenotype. I'm curious. Are we too soon for the benefits of that technology in that realm? Do we have decades to go or are we on the verge of using synthetic biology for treating individual patient problems?

Amy Gutmann:
Doctors? — including doctors on the Commission…

Drew Endy:
My sense is personalized medicine has decades to go with respect and the contribution of synthetic biology is probably around personalized pharmaceuticals and the ability to manufacture individually-tailored drugs within context on demand.

Amy Gutmann:
Nelson.

Nelson Michael:
Let me just say that our state of understanding of genomics and genome research is still quite in its infancy. So I think that the public concern, which is rightful, about personalized medicine is not going to be realized by cogent work in the laboratory for quite some time.

George Church:
I'm going to respectfully disagree a little bit here. I think personalized medicine is not necessarily about just going from a genome. You can integrate everything you currently have in medicine, plus the genome. And secondly, I don't think it's so far away. We already have 1800 genetic tests that are considered predictive and actionable. And personalized medicine is already having a huge impact in pharmaco-genetics and in cancer. So synthetic biology plus personal genomics I think is

uncertain, but I wouldn't say it's necessarily that far in the future.

Amy Gutmann:
Interesting. Drew.

Drew Endy:
I wanted to return to the public question from Dr. Bennett about context and just having the benefit of a couple of minutes to reflect upon what's new.

Amy Gutmann:
Could I just get Raju first? He has an answer on the personalized medicine.

Raju Kucherlapati:
I think that you pointed out, you know, right now we are utilizing genetic and genomic information to make diagnosis and prognosis and treatment decisions and that's what personalized medicine is. And many of the technologies to accomplish that are also technologies that also used in many other aspects, including synthetic biology. So even though I do not see any direct, you know, relevance to what we are talking about today in terms of synthetic biology, the technologies are very, very similar.

Amy Gutmann:
Drew, you're on.

Drew Endy:
Again, just returning to the question of, are there changes in context regarding ethics, and very practically, if I arbitrarily go back to circa 1975 and start with the early applications of recombinant DNA. Security as a topic was not considered at Pacific Growth. The scientists thought, following the decisions in the Nixon administration, the stand down of the biological weapons program, that was a solved problem. And if you talk to David Baltimore now, he will admit that's a naive mistake.

We live in a different world. We live in a world where people are concerned about security and terror. That's a significant difference to the ethical landscape. I think another point of significance is that we're

one human generation past the invention of genetic engineering. So, Paul Berg, is a distinguished colleague at Stanford and I'm honored to be able to learn from him. But he is an emeritus faculty. That means as a new generation comes up after the first synthetic engineering generation, we have the opportunity to pass along accrued wisdom and the information with it and maybe discard some baggage that is dysfunctional.

I think we're at a very interesting point in time—35-plus years post genetic engineering. And the third thing that's quite significant that wasn't true when a lot of these earlier conversations in bioethics happened: the Internet exists. Not to make a cliché of that, but people interact in many different ways. There are new types of communities and new types of representation and new types of dialogue. And I haven't seen—it may exist, but I haven't seen—a study of how this impacts the deliberation or practice of bioethics, but I bet it matters greatly.

Amy Gutmann:
Questions from commission members? Nelson.

Nelson Michael:
So there was several wide-range of opinions from a number of you in terms of what the role of governments—and I'll use the term instead of our single government, but of governments—and what their stewardship of this process would be.

On one hand, there's been some discussion of having an executive agent or executive process where there would be stewards from multiple agencies that would have allowed there to be a public and transparent discourse that might replicate this kind of forum, but do it in perpetuity that may transcend the political nature of the appointment lengths for this kind of process.

On the other hand, you know, we heard that there are some concerns about being sure the choke point of having information in the hands of governments, that even under best of intentions, in the absence of some degree of transparency, the consolidation of that oversight could turn into something else. That was your dual use 2.

So what maybe would be the recommendations for what role governments should play, so that you don't end up running afoul of either end of that spectrum?

Allen Buchanan:
I think you minimize the last risk that you mentioned, dual use 2. If you think about international governments, it's less likely that one country will be able to sort of get hold of the good information and use it for nefarious purposes. I think one difference in context Dr. Endy has mentioned several, we now live as opposed to say in 1975, we live in a world where international institutions are much more robustly developed than they have ever been. And I think that gives us an opportunity for international oversight and encouragement of the good uses of this technology that didn't exist before. So I would think about that. Think about which existing international institutions are such that you could piggyback some efforts for synthetic lab.

Amy Gutmann:
Allen, which would you put on your list?

Allen Buchanan:
I hadn't really thought about that question. I'm not sure whether it's a matter of piggybacking on something in the World Health Organization as sort of a starting point, or whether some other sort of international venue is needed. But this just leads to another thing.

I really think that you need somebody advising you—not me, because I'm not qualified to do it—but somebody advising you on institutional design with respect to recommendations you make that have implications for either how new institutions should be created or existing institutions should be modified to deal with these issues.

I think you really need somebody who is an expert on institutional design to think about incentive compatibility and when it's a matter of piggybacking on an existing institutional arrangement, either at the domestic level or internationally, when you need a genuinely new institution. Actually, your colleague, Bob Cohen is the person I wish we could go to first for advice on this.

Bonnie Bassler:

I think, Allison, you said this as one of your recommendations, you would ask the National Academy Board of Life Sciences to make one of their reports. It's actually a really good idea. That's what they sit around and do. And also all of the funding agencies, the government agencies are invested in those reports. So you can have the executive level recommendation, but if you want this to filter out to the science community, right, those reports many of which end up on a shelf, but some of them are highly influential if they are timed right. And I think to couple those two reports together could really give you some oomph.

What's really good about the NRC reports, they help you craft the question so you get maximum answers back. You know, it's not like you just get to give a question. They help and they are very good at refining it to make the question bigger, better, broader, if that's appropriate. Or to say you need two reports, one on risk, one on, I don't know, technology. But I think to explore that avenue is just one little line in your report to give it lasting—that gives you much more than your six-month time frame, too. Because those reports, you know, take a year.

Amy Gutmann:
We don't expect our report to be immortal. It's just the recommendations will—we want them to be self-replicating like the cell, right?

Bonnie Bassler:
Right, right. Automatically, yeah, in the spirit.

But to give yourself traction--like automatic extra traction.

Amy Gutmann:
Got it.

Raju, and then Christine.

Raju Kucherlapati:
I want to ask a question, but I want to preface this by a little history that many of us know about. The many issues we talked about are indeed very similar to what happened in the mid 1970s when recombinant DNA and the ability to splice molecules became available. At

that time, first the in the meeting there was a call for, you know, a moratorium on doing additional work. And then indeed, some parts of the country that I know very well, Princeton and Cambridge, for example, in the cities, they completely banned the use of any of those kinds of technologies. And then as a result of that, the National Institutes of Health formed the Recombinant Advisory Committee. And they developed guidelines to how we would be able to do research. And over the years, that has evolved. And over these last—all of these years, they have continued to evolve. And we began to recognize that it wasn't as dangerous as people thought that it was going to be. And that we were able to reap the benefits from it, despite the social issues that we have with regard to the use of recombinant DNA technology with plants and so on. And that was sort of considered as an example of how scientists are capable of regulating themselves in a reasonable fashion. Is that an example of a good model of how to do that? Or are there other things we have learned that say that is not a good model?

Amy Gutmann:
Yes. Rob.

Rob Carlson:
I can't address that question directly and I've been sort of mulling with it. But I have a bit of a revisionist view of Asilomar [Conference on recombinant DNA] and what happened there. That comes from spending time with Sidney Brenner. I was not there but Sidney was. His perspective has changed over the years. He said that Asilomar was motivated by desire to be just like the physicists: to have the power to destroy the world. And looking back on that, he says clearly, that was not correct. That the power of recombinant DNA then and today does not confer upon biologists the capacity they sort of hoped to have to compete culturally with physicists.

The second thing I would say about it is Asiloman brought to the fore a great number of promises, many of which have been born out, not all of which about the possibilities of recombinant DNA provides. It was also a chance to air a great many concerns and potential threats that the technology might bring forward.

And I would observe that both the promise and the peril there were listed by the same individuals, by the scientists who went. As we have

just heard, many of the potential threats didn't turn out to be there.

So Asilomar is a model for something, but I'm not sure it's the model to follow here because the potential for self-promotion is pretty strong.

Amy Gutmann:
Christine.

Christine Grady:
I wanted to ask… It seems like we have spent a lot of time talking about assessing risks and thinking about security and preparedness and all that. But we have had a couple of comments that were more along the lines of recommendations that we might be able to make that would support or maybe enable responsible progress in this area. And I think the funding for implications research is one of those, letting scientists be creative is another of those. But maybe there are others that we should think about. One of the ones I wondered about—let me throw it out here.

I sensed this morning that the integration of engineering and biology is something unique and that maybe some kind of more interdisciplinary something or other, education or ongoing dialogue or something, might be along the lines of what I'm thinking about. But anything like that, things that we might think about recommending that would support or enable responsible progress, rather than just putting brakes on.

Nita Farahany:
Can I just build on that question?

So Dr. Prather had raised the idea earlier potentially of something like the synthetic biology standardization project or something akin to like the human genome research project which Dr. Venter disagreed with. I wonder as you're answering that question if that's something like a standardization project or something, something that would be useful in a way to enable the science and the useful role for the government or not.

Drew Endy:

Yes.

[AUDIENCE LAUGHTER]

And there should be good discussion about what such projects might be. So if you can build a genome, can you build—and its software that makes its own hardware burdened with those metaphors, why not just call it wet ware.

If we use those metaphors, how about an operating system? How about we make the engineering version of a genome project? And its standardization and sharing and international and brings many people together and it's really challenging.

So I think there's tremendous opportunities around that.

I tried to mention very quickly this morning what I considered to be a very important opportunity to have public investment sustained in tools development. And in particular, DNA construction, but you could go into many different directions with that.

So I think there are tremendous opportunities there. No one person should have the privilege of figuring that all out, but we have good mechanisms for research and technology communities to come together with public policy groups to figure that out.

Amy Gutmann:
David, on this point.

David Rejeski:
I think one of the things the government could do is constantly monitor the changing structure of the industry as it grows. And we were doing this with nano tech because a lot of the work spun out of universities. All of a sudden, you had thousands of small businesses. And so the kinds of interventions you'd make and kinds of government agencies to get involved with small businesses, the kinds of things that small businesses use are quite often very different than the Dow Chemicals. So I think there's a tremendous need for something like the Department of Commerce to sort of say, what is the structure of this industry look like at this point in time? How can we support

them? Whether they need capital. Whether they need export promotion. Whether they need help with biosafety. There's a different set of agencies and strategies. I think the base of that is constantly monitoring a structure. of the industry. And it's going to change as it moves along. They all have very different needs and those needs will have to be answered quite often by different agencies and different outreach arms of different agencies.

Amy Gutmann:
Yes.

Paul Root Wolpe:
There are two ways the government can support something like this. One way is through the development of tools. And the other way is through directing the technology towards goals. So the government can support the creation of certain synthetic biology tools or it can say we're giving "X" amount of money for the creation, you know, for cures to the following disease or orphan diseases by synthetic biology means. So we have to differentiate the kinds of incentives that we're talking about to move it forward. It's probably premature for the latter, to start. It's still basic enough that probably the most productive thing the government can do at this point right now is to support tools, rather than goals. But it's probably not that much in the future where goals will become far more important and where there's an opportunity for this society as a whole through governmental agents to say given this enormously diverse set of activities, here are some of the places where we as a society want to put our resources to encourage you to accomplish the following things that are important to us.

Amy Gutmann:
So we have heard loud and clear, and I'm not going to sum up today. We have tomorrow as well. But I am going to draw this session to a close, simply by saying we have heard loud and clear, albeit sometimes from different people, that we need to think about the potential benefits as well as the risks and harms.

And let me just sum that point up by going back to the social justice issue. There are people today and people who are not yet here today whose lives can be saved and enhanced by what science today often unpredictably tomorrow creates. There are also concomitant risks and

harms we need to take into account. And I think it was a wise charge that we received to take both into account.

And all of the presenters together have addressed some of the benefits and the harms. And we will continue to pursue them and think about the institutional ways, domestic and international, in which those on the one hand harms, minimized risks, minimized but not going to zero, and benefits maximized. I know enough since I started as a mathematician to know you can't maximize and minimize at the same time. But we're going to think hard about this.

And I really want to conclude by saying thank you to everybody who has attended, to the presenters today. And we look forward to the presenters tomorrow. And above all, to my fellow commission members who have already shown that we have a commitment to this common enterprise, thank you all for coming. And enjoy your evening.

[APPLAUSE]